



The Energy Story

Chapter 7: Nuclear Energy - Fission and Fusion

Another major form of energy is nuclear energy, the energy that is trapped inside each atom. One of the laws of the universe is that matter and energy can't be created nor destroyed. But they can be changed in form.

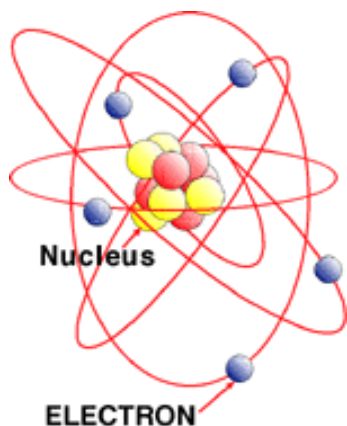
Matter can be changed into energy. The famous scientist Albert Einstein created the mathematical formula that explains this. It is:

$$E = mc^2$$

This equation says:

E [energy] equals **m** [mass] times **c**² [**c** stands for the speed of light. **c**² means c times c, or the speed of light raised to the second power -- or c-squared.]

Please note that some web browser software may not show an exponent (raising something to a power, a mathematical expression) on the Internet. Normally c-squared is shown with a smaller "2" placed above and to the right of the c.



Scientists used Einstein's famous equation as the key to unlock atomic energy and also create atomic bombs.

The ancient Greeks said the smallest part of nature is an atom. But they did not know 2,000 years ago about nature's even smaller parts.

As we learned in [chapter 2](#), atoms are made up of smaller particles -- a nucleus of protons and neutrons, surrounded by electrons which swirl around the nucleus much like the earth revolves around the sun.

Nuclear Fission

An atom's nucleus can be split apart. When this is done, a tremendous amount of energy is released. The energy is both heat and light energy. This energy, when let out slowly, can be harnessed to generate electricity. When it is let out all at once, it makes a tremendous explosion in an atomic bomb. The word fission means to split apart.

A nuclear power plant (like Diablo Canyon Nuclear

Plant shown on the right) uses uranium as a "fuel." Uranium is a rare metal that is dug out of the ground. It is processed into tiny pellets that are loaded into very long rods that are put into the power plant's reactor.

Inside the reactor of an atomic power plant, uranium atoms are split apart in a controlled chain reaction.

In a chain reaction, particles released by the splitting of the atom go off and strike other uranium atoms splitting those. Those particles given off split still other atoms in a chain reaction. In nuclear power plants, control rods are used to keep the splitting regulated so it doesn't go too fast.



If the reaction is not controlled, you could have an atomic bomb. But in atomic bombs, almost pure pieces of the element Uranium-235 or Plutonium, of a precise mass and shape, must be brought together and held together, with great force. These conditions are not present in a nuclear reactor.

The reaction also releases nuclear radiation. This is harmful to people, so the power plant's reactor is covered in thick concrete like the round dome buildings in the picture.

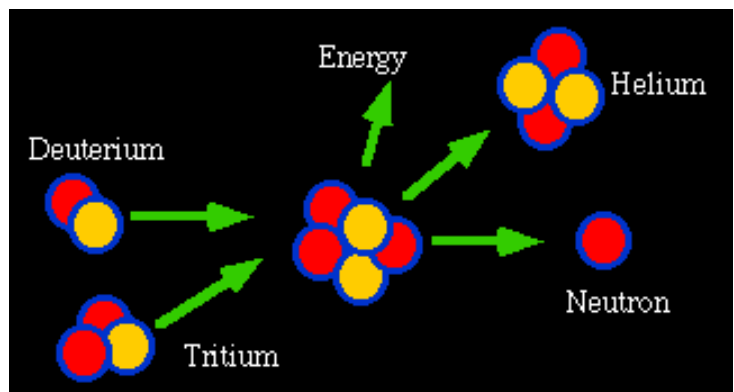
This chain reaction gives off heat energy. This heat energy is used to boil water in the core of the reactor. So, instead of burning a fuel, nuclear power plants use the chain reaction of atoms splitting to change the energy of atoms into heat energy.

This water from around the nuclear core is sent to another section of the power plant. Here it heats another set of pipes filled with water to make steam. The steam in this second set of pipes powers a turbine to generate electricity.

Nuclear Fusion

Another form of nuclear energy is called fusion. Fusion means joining smaller nuclei (the plural of nucleus) to make a larger nucleus. The sun uses nuclear fusion of hydrogen atoms into helium atoms. This gives off heat and light and other radiation.

In the picture to the left, two types of hydrogen atoms, deuterium and tritium, combine to make a helium atom and an extra particle called a neutron.



Also given off in this fusion reaction is energy! Thanks to the University of California, Berkeley for the picture.

Scientists have been working on controlling nuclear fusion for a long time, trying to make a fusion reactor to produce electricity. But they have been having trouble learning how to control the reaction in a contained space.

What's better about nuclear fusion is that less deadly nuclear radiation is given off.

You can learn more about nuclear fusion by visiting other locations on the Internet. The locations are:

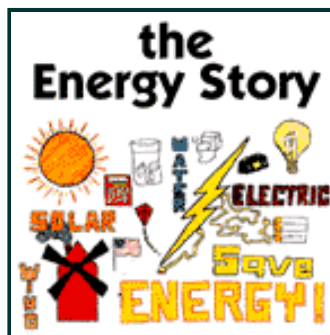
- [General Dynamics Fusion Education Program](#)
- [Joint European Torus Project - Introduction to Fusion](#)
- [University of California, Berkeley](#)

Here's What We Learned

1. Nuclear fission means splitting an atom apart.
2. Splitting an atom releases heat and light energy.
3. In a nuclear power plant, an atomic chain reaction is controlled to produce heat to boil water. That water boils water in pipes to make steam to turn a turbine and a generator to make electricity.
4. Nuclear fusion means combines atomic nuclei to make a larger nucleus.
5. The sun uses nuclear fusion of hydrogen into helium to make light and heat energy.
6. Scientists are trying to create nuclear fusion to make a cleaner source of power.

[Links to other nuclear web sites](#)

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